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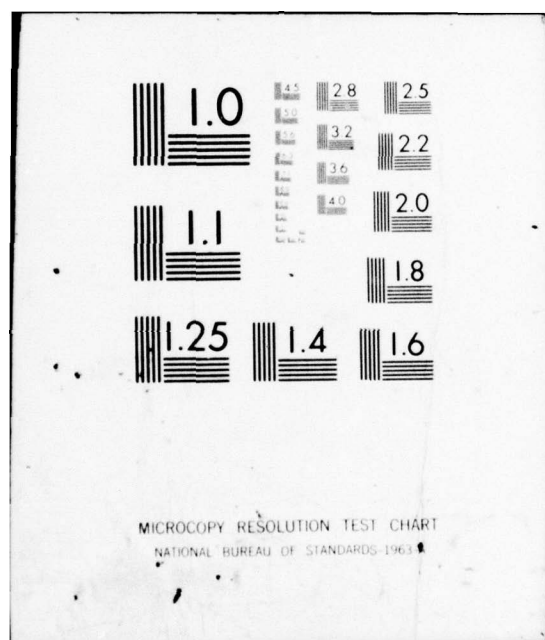
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**ENVIRONMENTAL DATA COLLECTED WITH
AUTOMATED FIELD STATION AT THE UPPER
BLAKELEY ISLAND DISPOSAL AREA
MOBILE, ALABAMA**

by

Margaret H. Smith, Herman M. Floyd, and Harold W. West

**Mobility and Environmental Systems Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180**

April 1977

Final Report

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20. ABSTRACT (Continued).

As a result of favorable comparisons in both laboratory and field tests, wind speeds measured by the automated station instruments are deemed accurate and reliable measurements of wind speeds at the containment area on Upper Blakely Island. In addition to wind speed, other data collected by the automated instrumentation include rainfall, wind direction, solar radiation, air and soil temperature, and pan evaporation.

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Preface

The study reported herein was sponsored by the Office, Chief of Engineers (OCE), U. S. Army, under the project "Dredged Material Densification Field Experiment." The work was performed from 18 December 1975 through 12 May 1976 by personnel of the Environmental Simulation Branch (ESB), Environmental Systems Division (ESD), Mobility and Environmental Systems Laboratory (MESL), U. S. Army Engineer Waterways Experiment Station (WES), under the direct supervision of Messrs. J. K. Stoll, Chief, ESB, and H. W. West, Project Manager. The study was conducted under the general supervision of Messrs. W. G. Shockley, Chief, MESL, and B. O. Benn, Chief, ESD. Dr. T. A. Haliburton, Technical Consultant, Environmental Effects Laboratory, WES, was the Technical Monitor for the project. Mr. H. M. Floyd, Instrumentation Services Division, WES, was responsible for the installation and maintenance of the field instrumentation, and Ms. M. H. Smith, ESB, was responsible for processing the field data into engineering units. The report was prepared by Ms. Smith, and Messrs. Floyd and West.

The automated system used at Upper Blakeley Island and discussed herein for collecting, processing, and displaying environmental baseline data was developed by the MESL under Department of the Army Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities," Task 01, "Environmental Quality Management for Military Facilities," Work Unit 006, "Methodology for Characterization of Military Installations Environmental Baselines," sponsored by the Directorate of Military Construction, OCE.

COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of the WES during this study and report preparation. Mr. F. R. Brown was Technical Director.

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Conversion Factors, Metric (SI) to U. S. Customary and
U. S. Customary to Metric (SI) Units of Measurement

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
<u>Metric (SI) to U. S. Customary</u>		
millimetres	0.03937007	inches
centimetres	0.3937007	inches
metres	3.280839	feet
grams	0.00204622	pounds (mass)
kilograms	2.204622	pounds (mass)
milligrams per litre	6.242797×10^{-5}	pounds (mass) per cubic foot
milligrams per litre	1.0	parts per million
metres per second	2.236936	miles (U. S. statute) per hour
kilometres per hour	0.6213711	miles (U. S. statute) per hour
milliwatts per square centimetre	0.01434	Langley's per minute
Celsius degrees	1.8	Fahrenheit degrees*
<u>U. S. Customary to Metric (SI)</u>		
inches	2.54	centimetres
feet	30.48	centimetres
miles (U. S. statute) per hour	0.44704	metres per second
degrees (angular)	0.01745329	radians

* To obtain Fahrenheit (F) degrees from Celsius (C) readings, use the following formula: $F = 1.8(C) + 32$. To obtain Fahrenheit readings from Kelvins, use: $F = 1.8(K - 273.15) + 32$.

ENVIRONMENTAL DATA COLLECTED WITH AUTOMATED FIELD STATION AT THE
UPPER BLAKELEY ISLAND DISPOSAL AREA, MOBILE, ALABAMA

Background

1. The Environmental Effects Laboratory (EEL) of the U. S. Army Engineer Waterways Experiment Station (WES) is conducting field experiments at Upper Blakeley Island near Mobile, Alabama, in connection with its Dredged Material Research Program. The field program consists of several independent studies to evaluate the short- and long-range effects of different dewatering techniques that are being developed to help reduce the time required for densification of dredged material in diked containment areas. Dewatering should reduce the volume of material in the diked containment areas, thereby, increasing the useful life of the disposal facility.

2. Since some of the dewatering techniques are highly dependent on local meteorological conditions, a set of data that describe these conditions is needed throughout the experiments. This "baseline" will provide data for analyzing experimental results and designing future field experiments or prototype disposal techniques.

Purpose and Scope

3. This report describes the system of instruments that were used for acquisition of environmental data in support of field experiments on methods of densifying dredged material in containment areas at Mobile, Alabama. Examples are presented of the environmental data that were obtained from 18 December 1975 through 12 May 1976. In addition, wind speeds as measured and recorded by sensors incorporated in the WES system of instruments are compared with those measured and recorded by another instrument.

Automated Field Station

4. The automated field station used at the Upper Blakeley Island disposal area was composed of one 32-channel Lockheed Electronics Corporation (LEC) 101R digital recorder (Figure 1) interfaced with 11 environmental sensors.* It was installed at the location shown in Figure 2. The field station has been designed to meet the need for an unattended data gathering facility capable of measuring environmental and engineering parameters and recording the data on magnetic (cassette) tape at any of 10 different time intervals. The LEC recorder can accept, condition, and record data from a wide variety of sensors that provide digital, impedance, or low-level voltaic output. The recorder is battery- and solar-powered and is capable of recording data from as many as 31 sensors (reserving one channel for internal interrogation) over a relatively long time. A unique design feature of the recorder is its low standby power consumption. Low power consumption is achieved by deactivation of all circuits, except essential control circuits, during periods when no information is being processed and recorded. When the preselected sampling time occurs, the recorder is automatically activated while the data from all the sensors are being conditioned and recorded and then deactivated upon completion of the process. Since the time required for this process is very short compared with time between sampling periods, the average power consumption is held to a minimum. The recorder's solar panel provides the capability for recharging the battery over long data collection periods.

* For a detailed discussion of the LEC 101R field recorder and selected sensors see H. W. West and H. M. Floyd, "An Automated System for Collecting, Processing, and Displaying Environmental Baseline Data," Technical Report No. M-76-11, Nov 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Mississippi.

Descriptions of Sensors

5. Data were obtained at 15-, 30-, and 60-min sampling intervals with sensors that measure the following parameters:

- a. Rainfall
- b. Wind speed at 8 m^{*} above ground
- c. Wind speed at 2 m above ground
- d. Wind direction at 8 m above ground
- e. Wind direction at 2 m above ground
- f. Solar radiation (two sensors at 2 m above ground)
- g. Air temperature at 2 m above ground
- h. Evaporation (pan)
- i. Soil temperature at a depth of 0.15 m
- j. Soil temperature at a depth of 1.52 m

Figure 3 shows the field recorder and sensors at the Mobile disposal area. Descriptions of the sensors with appropriate mathematical relations are given in the following paragraphs.

Rainfall

6. Rainfall was measured continuously with a Weather Measure^{**} Model P-501 rain gage (Figure 4). All internal parts are aluminum, chrome-plated brass, or stainless steel. The rain gage has a 20.3-cm-diam orifice protected by a heavy brass ring and has a tipping-bucket mechanism coupled to a mercury switch to produce an output. The tipping-bucket mechanism consists of balanced polyethylene buckets suspended on stainless steel pivots.

7. As rainfall enters the orifice, it is drained to the gage's interior into one of the two buckets in the tipping mechanism (Figure 5). When one bucket is full, the weight of the water causes it to tip and the second bucket swings into place beneath the entry funnel. As each bucket tips, the water drains out through the base of the gage. The tipping action causes a mercury switch beneath the

* A table of factors of converting metric (SI) units to U. S. customary units of measurement, and U. S. customary to metric (SI), is given on page 4.

** Weather Measure Corporation, Sacramento, California.

tipping-bucket mechanism to close momentarily. The gage is calibrated such that one switch closure is produced for each 0.254 mm of rainfall. The closures are accumulated over each sampling time interval, and the total is recorded on magnetic tape. The total amount of rainfall (in mm) is computed by the following equation:

$$\text{Rainfall} = \text{No. of switch closures for specified recording period} \times 0.254$$

Wind speed

8. Wind speed was measured at 2 m and 8 m above ground level continuously with a Climet^{*} Model 011-2B wind-speed sensor (Figure 6), an accurate, durable, 3-cup-type, 0- to 161-km/hr anemometer. As the anemometer rotates, it activates a sealed magnetic reed switch by means of a magnet attached to the sensor shaft. The output signal is a series of contact closures at a frequency proportional to wind speed. Reliability of the sensor is insured by incorporation of rugged materials; namely, Lexan anemometer cups, a stainless steel shaft, Teflon-sealed stainless steel bearings, cast and machined anodized aluminum housing, etc., and careful selection of seals and weatherproof connectors.

9. Detailed characteristics of the wind-speed sensor are:

- a. Range: 0.559-44.704 m/sec.
- b. Calibrated accuracy: ± 2 percent or 0.11 m/sec, whichever is greater.
- c. Output: 2 switch closures per revolution.

10. The switch closures during each preselected sampling time interval are counted, and the total number is transferred to magnetic tape. Intervals of 15, 30, and 60 min were used in the data collection at the Mobile disposal area. An average speed over the selected time

* Climet Instruments, Sunnyvale, California

interval (in m/sec) is then obtained by applying the appropriate constant in the equation

$$\text{Average wind speed} = \text{No. of switch closures} \times (X_i) \times (0.44704)$$

where

X_i = the constant for time interval i

i = time interval in minutes; for $i = 15$ min, $X = 0.001753$;
for $i = 30$ min, $X = 0.000876$; for $i = 60$ min,
 $X = 0.000438$

Wind direction

11. Wind direction was measured at 2 m and 8 m above ground level by a Climet Model 012-2B wind-direction sensor (Figure 7), which is a companion to the 011-2B wind-speed sensor. An airfoil wind vane and a precision potentiometer assembly deliver a resistance analogous to the azimuth bearing from which the wind is blowing. The wind-direction sensor is made of the same rugged materials and has the same type of seals as the wind-speed sensor.

12. Detailed characteristics of the wind-direction sensor are:

- a. Mechanical azimuth range: 0-360 deg.
- b. Electrical azimuth range: 0-354 \pm 2 deg.
- c. Calibrated accuracy: \pm 5 deg.
- d. Resolution: 0.5 deg.
- e. Minimum wind speed for direction measurement:
0.559 m/sec.

13. A sensor output of 15,000 ohms corresponds to an azimuth of 0 deg (tape value = 0), and 5000 ohms corresponds to an azimuth of 356 deg (tape value = 712). A "dead band," 357-359 deg, exists for which the sensor has no output, and all azimuths in this range are interpreted as 358 deg. The recorded tape value is converted to wind direction (in deg) from north (clockwise) by:

$$\text{Wind direction} = \text{Recorded tape value} \div 2$$

Solar radiation

14. Solar radiation was measured with two Matrix^{*} Mark 1-G Sol-A-Meters (Figure 8). This sensor is composed of a silicon photovoltaic-cell pyranometer with a spectral response from 0.35 to 1.15 μm with a peak sensitivity of 0.85 μm . It is temperature-compensated (-40 to $+60^{\circ}\text{C}$) and generates a millivolt signal output that is proportional to the total incident radiation. The cell is mounted under a rugged Pyrex hemisphere for protection and takes less than 1 msec for 0-100 percent response.

15. Some other characteristics of the Matrix Sol-A-Meter are:

- a. Range (nominal): $0-140 \text{ mW cm}^{-2}$.
- b. Calibrated accuracy: ± 5 percent.
- c. Size: Base diameter, 12.7 cm.
- d. Weight: 680 g (1-1/2 lb).

16. The Sol-A-Meter can be used in at least three ways: (a) to measure incident radiation over its entire bandwidth (i.e. 0.35-1.15 μm), (b) to measure reflected radiation by inverting the sensor, and (c) to measure radiation in a specific bandwidth by using special filters. Only incident radiation was measured at the site of the field experiments.

17. Each Sol-A-Meter was precalibrated at the factory by comparison with a thermopile-type radiometer in bright sunshine on clear days. An example factory calibration curve is given in Figure 9.

18. The signal output of the sensor is related to solar radiation by the following equation.

$$R = 69.73(av + b)$$

where

R = radiation in mW cm^{-2}

a = slope of the calibration curve (Figure 9) and is ≈ 0.02 dependent upon the individual sensor

* Matrix Inc., Mesa, Arizona.

v = output of sensor, mV.

b = the zero offset and is ≈ 0.04 dependent upon the individual sensor.

69.73 = conversion constant (cal per cm^2 per min to mW per cm^2).

Air and soil temperatures

19. Air and soil temperatures (at depths of 0.15 m and 1.52 m) were measured with Lockheed Model S1081 and S1071 sensors, respectively (Figure 10). These sensors incorporate a thermoliner thermistor network as the sensing element. The network is a composite device consisting of resistors and thermistors configured to produce an output resistance that is related to temperature as follows:

$$t = \frac{R_t - k_2}{k_1}$$

where

t = temperature, $^{\circ}\text{C}$

R_t = total sensor resistance, ohms

k_1 = 127 ohms/ $^{\circ}\text{C}$

k_2 = 12,176 ohms

20. The sensors are constructed in the following ways:

- a. The air sensor enclosure is constructed with a triple shield that eliminates the effect of both direct and reflected solar radiation (in the case of air-temperature measurements) upon the sensing element. A "chimney" design creates a smooth flow of the ambient air around the sensing element without forced aspiration.
- b. The soil sensor is potted in the nose of an aluminum, bullet-shaped, conductive housing such that it can be pressed into the soil at the depth desired. The thermoliner network and wiring are potted in a moisture-proof housing. The time required for the sensor, in its housing, to indicate 63 percent of a change in temperature in most soils is approximately 20 sec.

The sensors produce a linear output of 0-1.0 V over a temperature range of -40 to $+60^{\circ}\text{C}$. Characteristics of the sensors are:

- a. Temperature range: -40 to $+60^{\circ}\text{C}$.

b. Calibrated accuracy: $\pm 0.15^{\circ}\text{C}$.

c. Sensitivity: 127 ohms/ $^{\circ}\text{C}$.

21. Air and soil temperatures (in $^{\circ}\text{C}$) are determined by the following equation:

$$\text{Temperature} = (\text{Recorded tape value} - 400) \div 10$$

where

400 = zero offset constant

Pan evaporation

22. Pan evaporation was measured with a Universal Engineered Systems* Model T-66 position (water-level) sensor (Figure 11) in conjunction with a Weather Measure Corporation E816 evaporation pan and a WES-constructed still well.

23. As installed in the field, the water-level sensor (Model T-66) is mounted on a horizontal platform directly above the evaporation pan (Figure 3). A polymer float rides on the water surface and is connected by a stainless steel tape to the tape wheel and gearbox, which, in turn, position a precision potentiometer as the water evaporates. Optimum sensitivity is provided by antibacklash gears and precision stainless steel bearings. The T-66 is contained in an all-weather cast aluminum enclosure and has a tripod mounting for level adjustment. The function of the still well is to provide a plane surface free of ripples upon which the float can ride.

24. Characteristics of the T-66 water-level sensor are:

- a. Range of measurements: 0-0.33 m.
- b. Calibrated accuracy: 0.2 percent.
- c. Sensitivity: 0.05 percent.
- d. Resistance: Potentiometer: 10,000 to 15,000 ohms.
- e. Floats: Extruded polymer, 30.5-cm diam.
- f. Standard tape wheel: 60.96-cm circumference; aluminum with stainless steel indexing pins spaced 15.2 cm apart.
- g. Dimensions: 0.23 m wide by 0.46 m high by 0.23 m deep.
- h. Weight: Approximately 9.07 kg (20 lb).

* Pleasanton, California.

25. The T-66 linear resistance range of 15,000 to 10,000 ohms corresponds to a range of 100 to 900 mV recorded on the magnetic tape. The following equations are used to compute evaporation.

$$EL_w = (V_r - V_o) \times 0.0025 \times 30.48$$

where

EL_w = elevation (in cm) of water above zero

V_r = recorded tape value

V_o = tape value at zero

0.0025 = elevation constant (feet/count)

30.48 = conversion constant (feet to cm)

and

$$VAP = EL_{w1} - EL_{w2}$$

where

VAP = pan evaporation

EL_{w1} = elevation of water at previous recorded time *

EL_{w2} = elevation at present time *

Field Data Collected

26. The environmental data for the Upper Blakeley Island disposal area were recorded on cassette tapes as follows:

* Zero evaporation will show as zero.

<u>Cassette Tape No.</u>	<u>Data Collection Period</u>	<u>Sampling Interval, min</u>
1	18 Dec 75 - 8 Jan 76	15
2	9 Jan 76 - 15 Jan 76	15
3	15 Jan 76 - 26 Jan 76	15
4	27 Jan 76 - 12 Feb 76	30
5	13 Feb 76 - 25 Feb 76	60
6	26 Feb 76 - 2 Mar 76	60
7	12 Mar 76 - 30 Mar 76	15
8	9 Apr 76 - 21 Apr 76	60
9	23 Apr 76 - 12 May 76	60

27. The cassette tapes were taken to the WES for data translation, processing, and display. The processing and display were accomplished through the use of a software package using the 16K-memory PDP-15/30 Digital Equipment Corporation computer.

Examples of Tabular and Graphic Data

28. The environmental data collected at the experimental site are presented in different formats as described below.

- a. Tabular data. Tabulations (Figure 12) are provided for all sensors for each 15-, 30-, or 60-min sampling interval used. One line of data in the computer printout represents one sampling interval of data collection.
- b. Graphic data. The data are also presented in two different graphic formats. The first is a line plot (Figure 13) or bargraph (Figure 14) depicting individual measurements for each sampling interval. Each graph contains data for a period of 7 days. The second format is a line plot (Figure 15) showing the maximum, minimum, and average values for a parameter over the data collection period (several days) at each programmed recording time in 24 hr. For example, the maximum, average, and minimum values for wind speed at a height of 8 m above ground level for the period of 18-23 December 1975 are included in Figure 15. The maximum and minimum measured wind speeds during the 18-23 December 1975 period at 1200 hr were 4.61 m/sec and

1.96 m/sec, respectively. The computed average wind speed at 1200 hr during the 6-day period was 2.8 m/sec.

- c. Wind-direction data. Data for wind direction are presented in a wind rose format as shown in Figure 16. The relative lengths of lines radiating from the center indicate the percentage frequency that the winds blow from eight principal wind directions (north, northeast, east, southeast, south, southwest, west, northwest). Each direction includes all recorded wind directions in a band of 22.5 deg either side of the principal direction.

The tabular and graphic data have not been included in this report. However, the data are on file at the WES and are available on loan. Persons interested may borrow copies by writing the Commander and Director, U. S. Army Engineer Waterways Experiment Station, ATTN: WESFE, P. O. Box 631, Vicksburg, Miss. 39180.

Laboratory and Field-Measured Wind Speeds

29. Since some of the experiments being conducted at the disposal site were highly dependent upon the amount of wind available at the site, it was decided to conduct additional tests to insure proper calibration of the wind-speed sensors. The results of these experiments are discussed below.

30. Wind-speed data were collected both in the laboratory and in the field with two different measuring and recording systems, the LEC 101R field recorder equipped with a Climet Model 011-2B wind-speed sensor and a Meteorology Research, Inc. (MRI) weather station with wind-speed sensor using a strip-chart recording system. In the laboratory, a relatively constant wind was generated by placing a fan at a fixed distance from the wind-speed sensor. Wind speeds were first recorded by the MRI system and then by the LEC system, both for approximately 1 hr. Field tests were also conducted at the Upper Blakeley Island disposal area, Mobile, Alabama, where wind-speed data were recorded for a period of 22 hr.

31. The LEC field recorder records wind speed by counting the total number of switch closures (2 per revolution) produced by the anemometer (paragraph 8) for a selected interval. At the end of the interval, the number of switch closures or counts is recorded on magnetic tape, and the counter zeroed to begin the next interval. The raw data thus represent the total wind that has passed the anemometer during the selected interval. To obtain a true average wind speed, it is necessary only to divide by time and then convert from counts/sec to mph or m/sec. The constants provided with the instrumentation convert revolutions to mph. For the comparison exercise, data are expressed in mph.

32. Average wind speed as recorded in the laboratory by the LEC recorder and wind-speed sensor for the 1-hr period was 5.965 mph, and was calculated by summing the counts for 20 intervals of 3 min each (Figure 17). The sums were converted to mph as follows:

$$13,615 \frac{\text{counts}}{\text{hr}} \times \frac{\text{hr}}{3600 \text{ sec}} \times \frac{\text{mph}}{0.634 \text{ counts/sec}} = 5.965 \text{ mph}$$

33. Note that the wind speed as measured at 3-min intervals by the sensor varied from a low of 523 counts (4.583 mph) to a high of 884 counts (7.75 mph), reflecting short-term changes in wind velocity. These data make clear that in order to obtain a true average, it is necessary to have continuous sensing of wind currents rather than periodic sensing. Therefore, the Climet sensor in the LEC system was designed to accumulate counts over a specified period of record and present the average wind speed in mph for that period.

34. The MRI wind-speed sensor and recording system measures wind speed by mechanically connecting, through a series of gears, the rotating anemometer shaft to a stylus, which writes on pressure-sensitive chart paper. Thus, every revolution moves the stylus imperceptibly, and once every 30 sec the chart drive moves forward one

increment. The overall effect is to draw a line, the slope of which is wind speed in mph.

35. Average wind speed as computed from the time and distance data taken from MRI strip chart in the laboratory for the 1-hr period was 6.45 mph (Figure 18). This wind-speed measurement is slightly higher than that measured and digitally recorded by the LEC system for the 1-hr time interval.

36. During the field experiment at the disposal site, the MRI and the Climet Model 011-2B sensors were installed at a height of 2 m, and data were collected from 1015 hr, 11 March 1976. to 0800 hr, 12 March 1976. The LEC field recorder was set for 15-min sampling intervals. Conversion of the raw cassette tape data from the LEC recorder to mph was accomplished using the following equation.

$$\text{Wind speed (mph)} = (\text{LEC recorder counts}) (X_1)$$

where

$$X_1 = \text{constant for the 15-min sampling interval and equal to } 0.001753$$

A tabulation of wind-speed data obtained with both measuring and recording systems is presented in Figure 19. The raw data obtained on the LEC recorder are presented in the second column, and direct conversion to mph in the third column. The LEC average wind-speed data for a 1-hr interval is given in the fourth column and was obtained by averaging each of four 15-min-interval wind speeds. The wind-speed data obtained with the MRI system are presented in the fifth column and were determined from the MRI strip chart contained in Figure 20.

37. A comparison of the wind speeds as measured with the two systems is shown in Figure 21. It is noteworthy that the data from the MRI system is somewhat greater than that for the LEC system for wind speeds up to approximately 7 mph and is somewhat lower for wind

speeds between 7 and 11 mph. These differences are primarily attributed to the fact that the average wind speeds for the MRI system were obtained by the crude method of projecting a visual line of best fit through the time-distance curves (Figure 20) for each 1-hr period. The slope of this line was then considered to be the average wind speed for the 1-hr interval. Even with this crude method of determining wind speed, the two sets of data are considered very close. The mean difference and variance of the two sets of data are 0.67 and 0.19 mph, respectively.

38. As a result of these limited field experiments, it was felt that the LEC recorder with the Climet sensor for measuring and recording wind speeds provides accurate and reliable measurements of wind speeds for the purposes of determining if sustained winds are available for the field experiments and also to provide average wind-speed data to determine the effects of wind currents on the drying of dredged material within the disposal site.

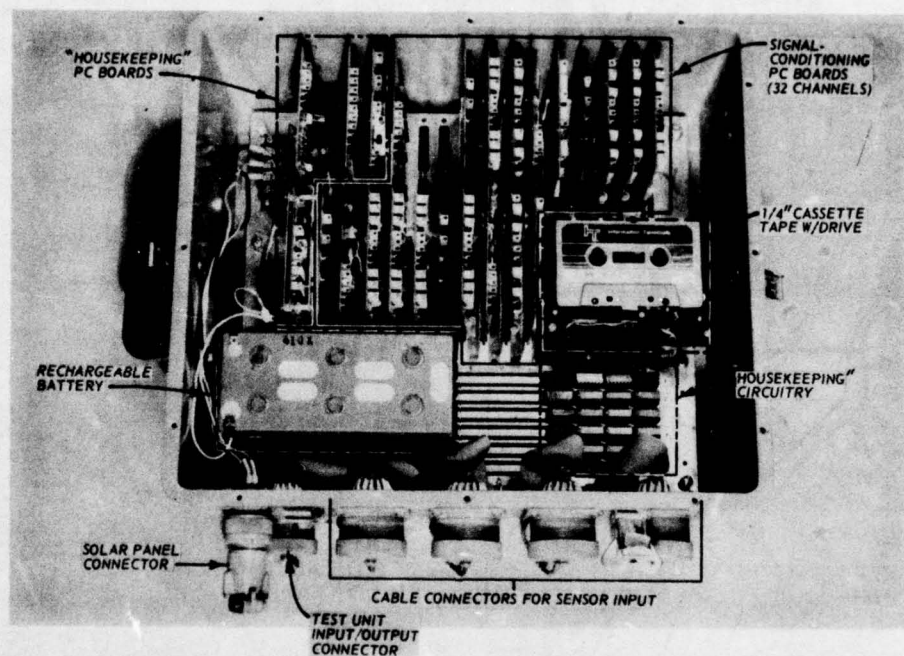


Figure 1. LEC field recorder

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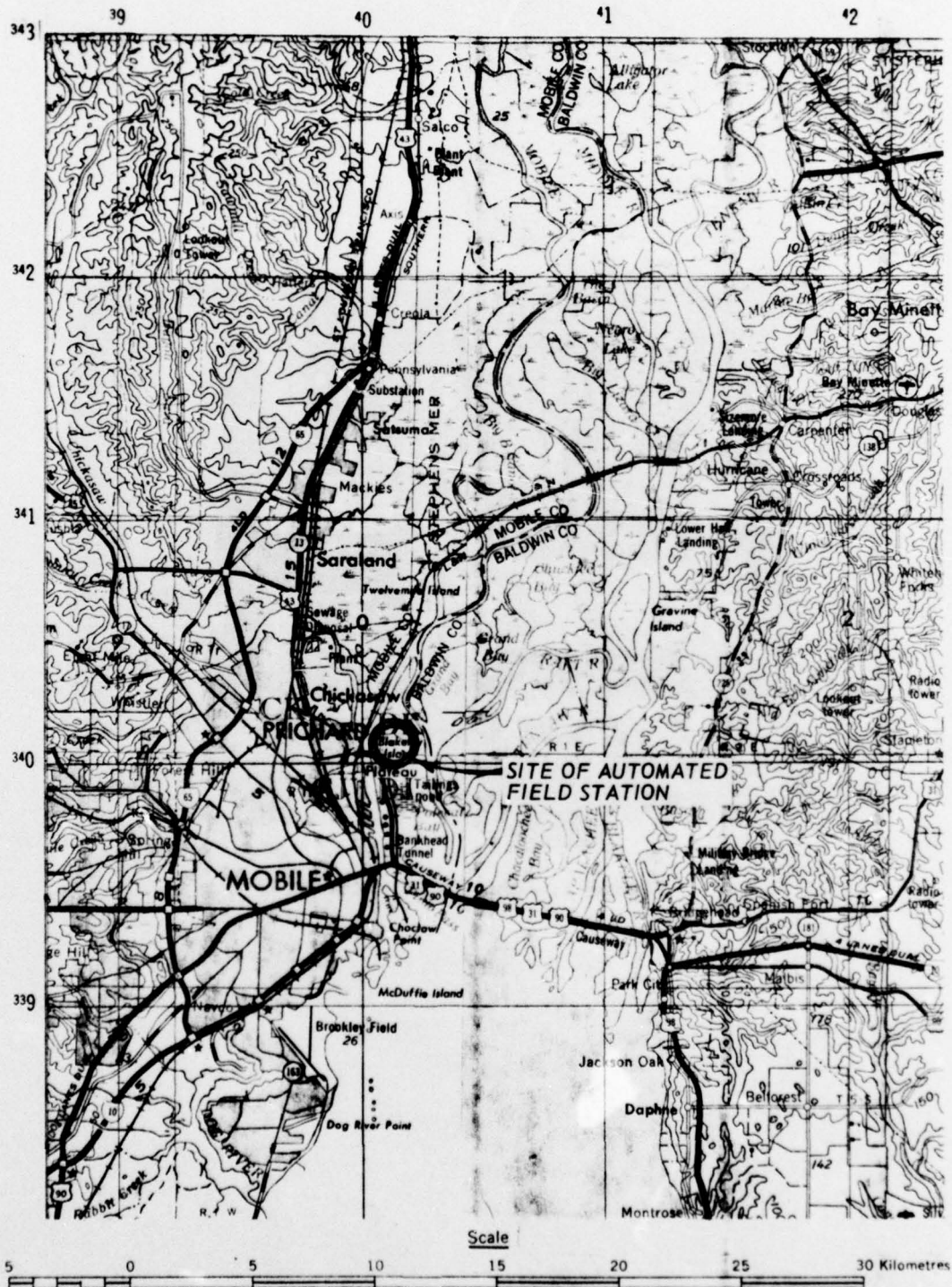
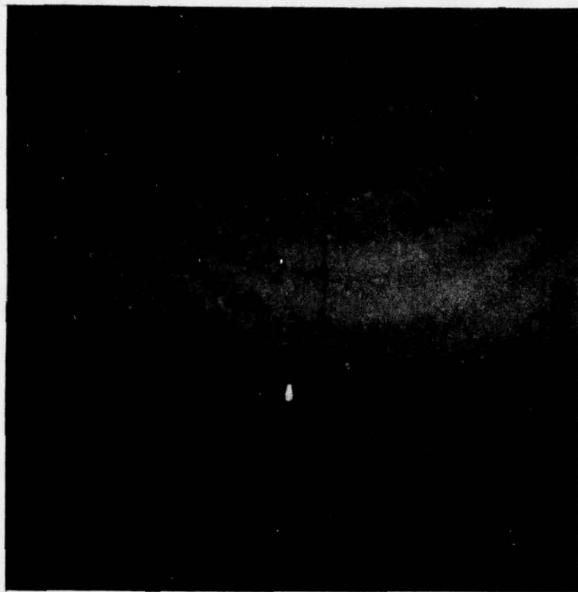
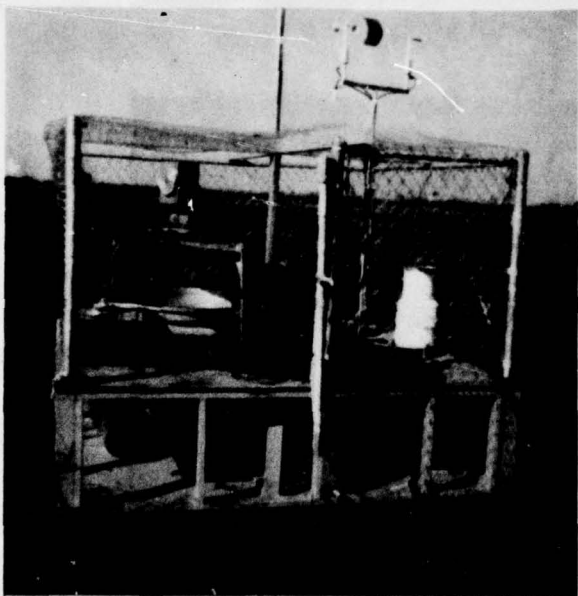


Figure 2. Location of automated field station



a. Automated field station



b. Close-up view of the station

SENSORS

- Rainfall
- Windspeed (2 and 8 m above ground)
- Wind direction (2 and 8 m above ground)
- Solar radiation (2 sensors)
- Air temperature
- Evaporation (pan)
- Soil temperature (0.15- and 1.52-m depth)

Figure 3. Automated field station, Upper Blakeley Island disposal area, Mobile, Alabama

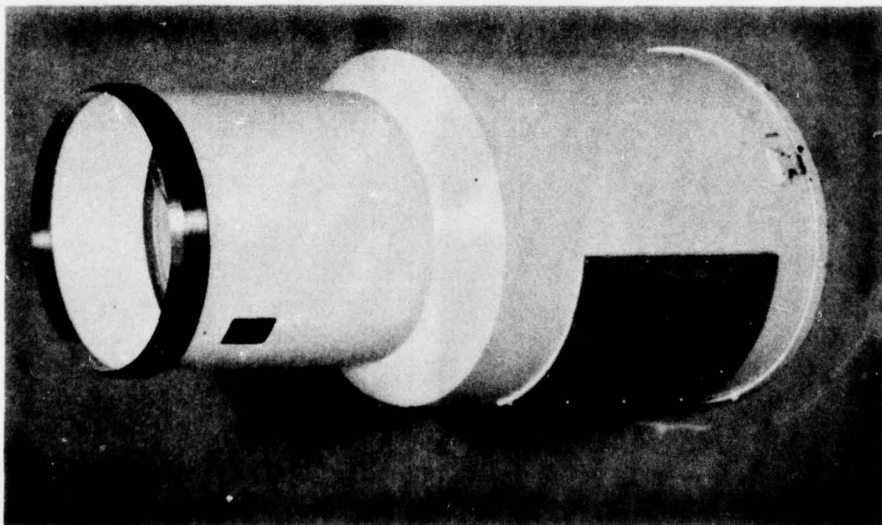


Figure 4. Weather Measure Model
P-501 rain gage

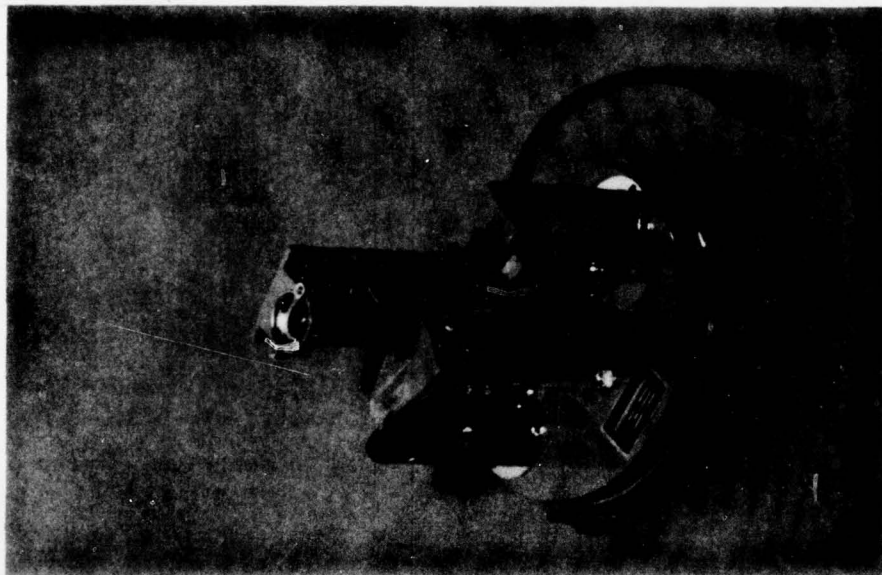


Figure 5. Interior of Weather
Measure Model P-501 rain gage show-
ing tipping-bucket mechanism

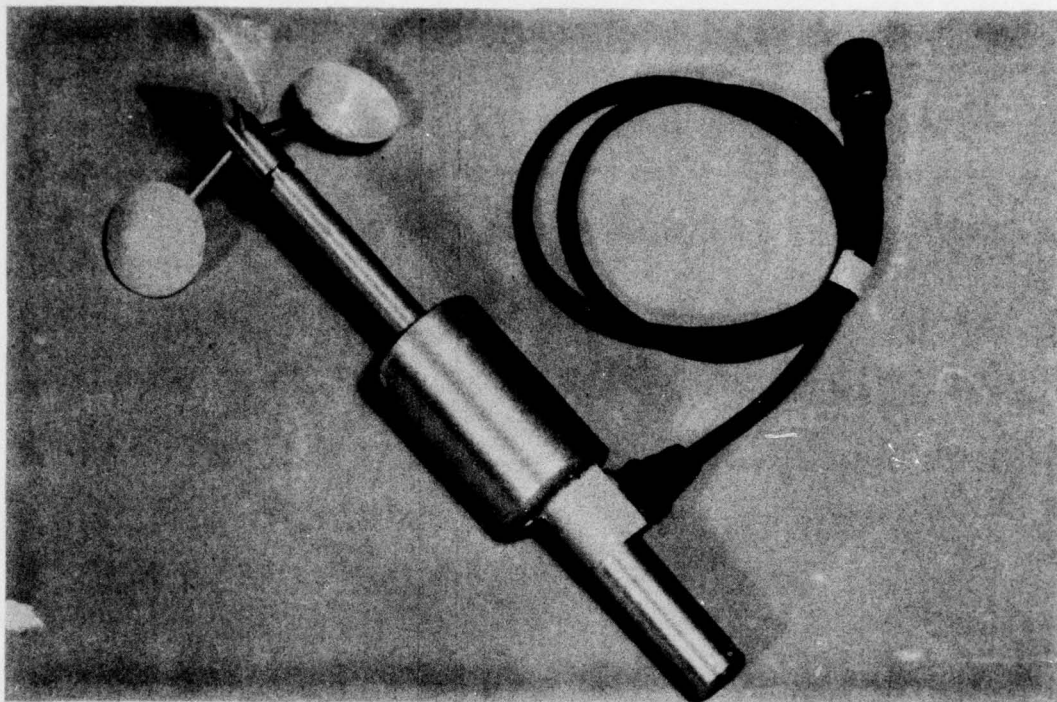


Figure 6. Climet Instruments Model 011-2B wind-speed sensor

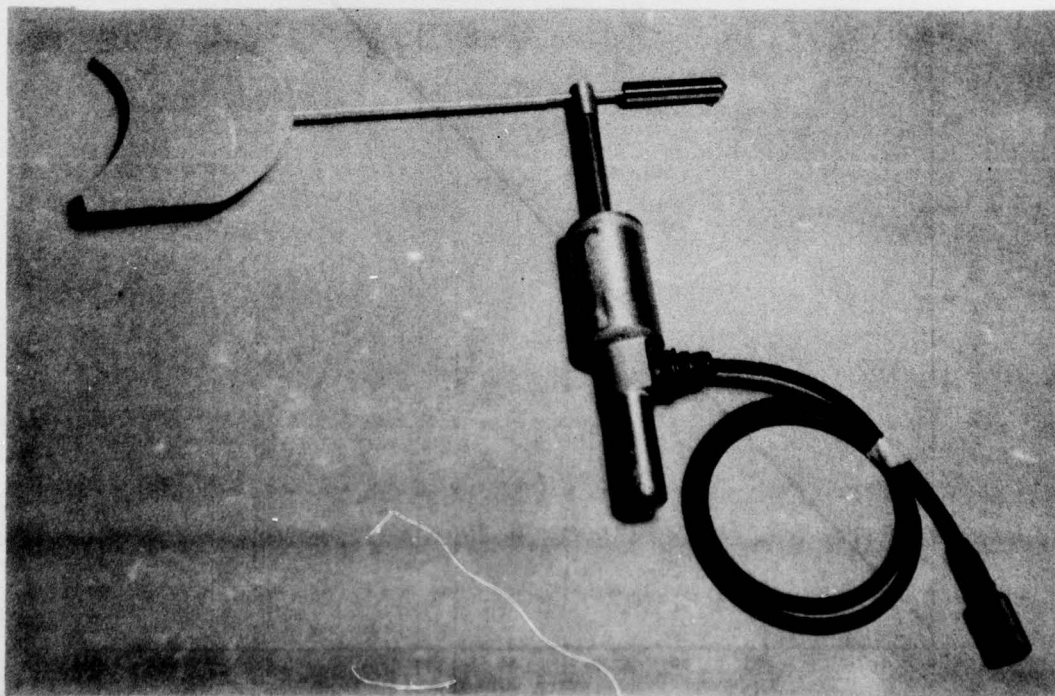


Figure 7. Climet Instruments Model 012-2B wind-direction sensor

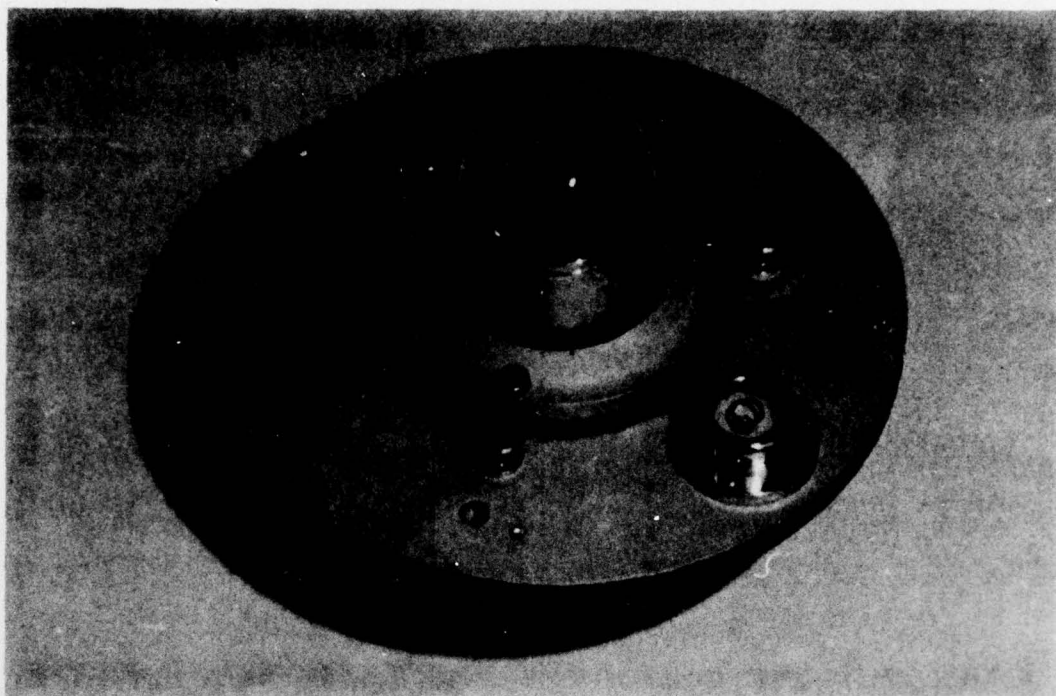


Figure 8. Matrix Mark I-G Sol-A-Meter

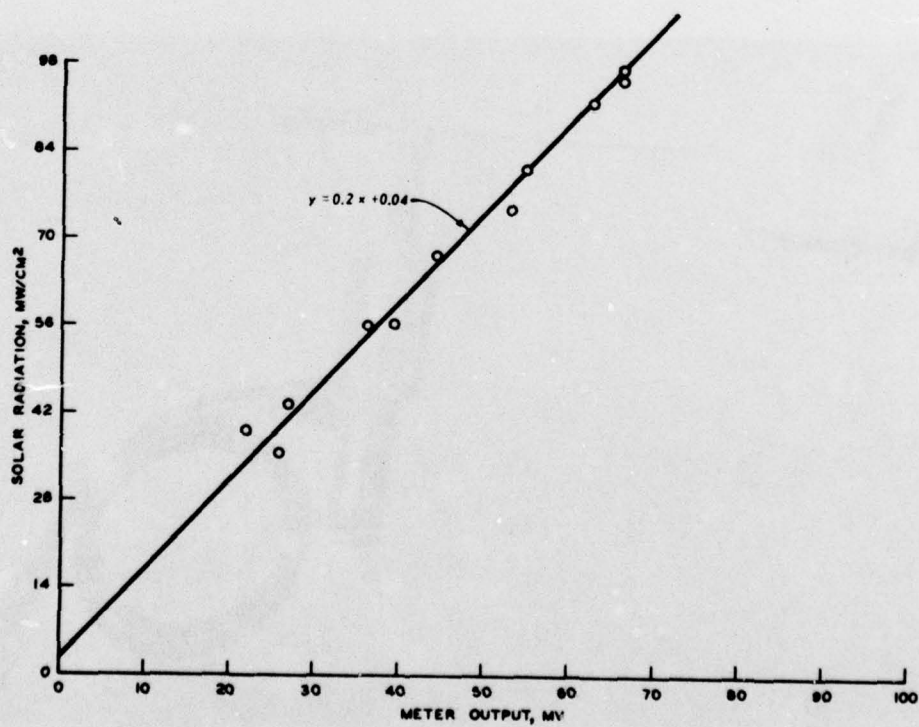
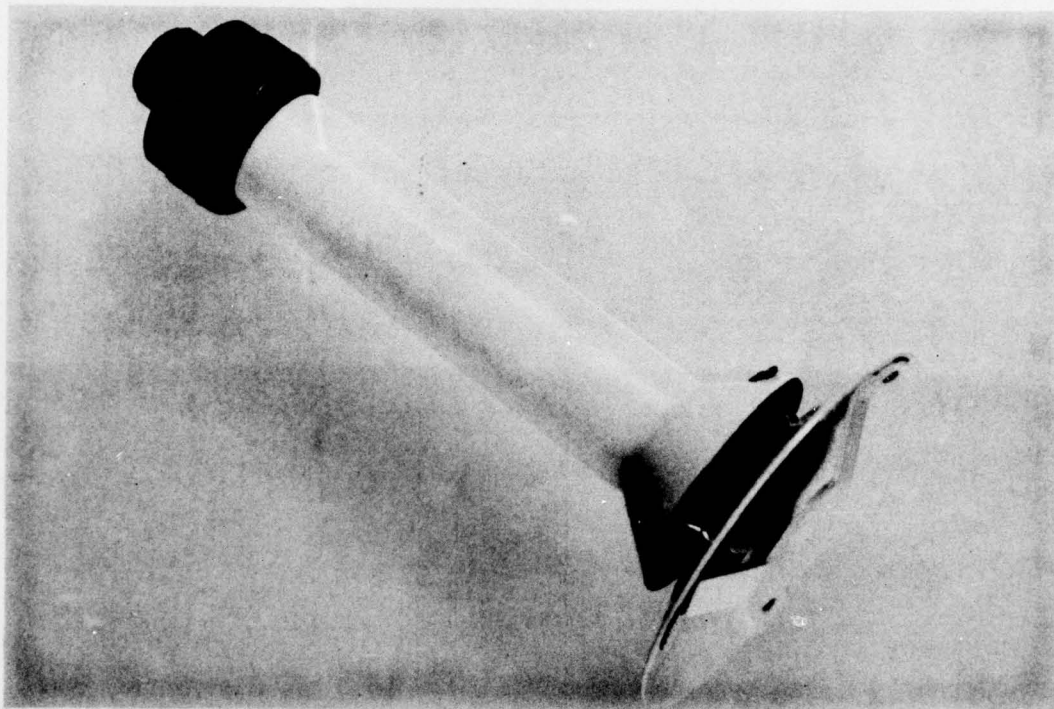
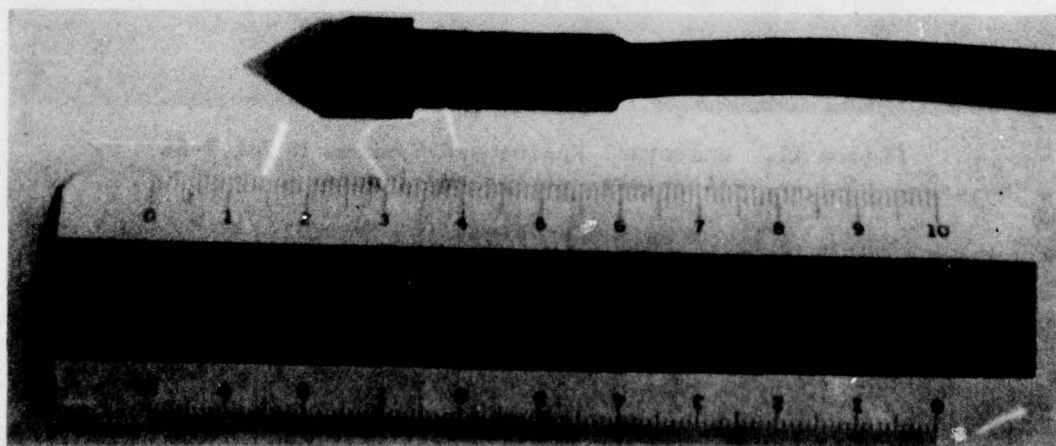


Figure 9. Example calibration curve for Matrix Mark I-G Sol-A-Meter



a. Model S1081



b. Model S1071

Figure 10. Lockheed temperature sensors

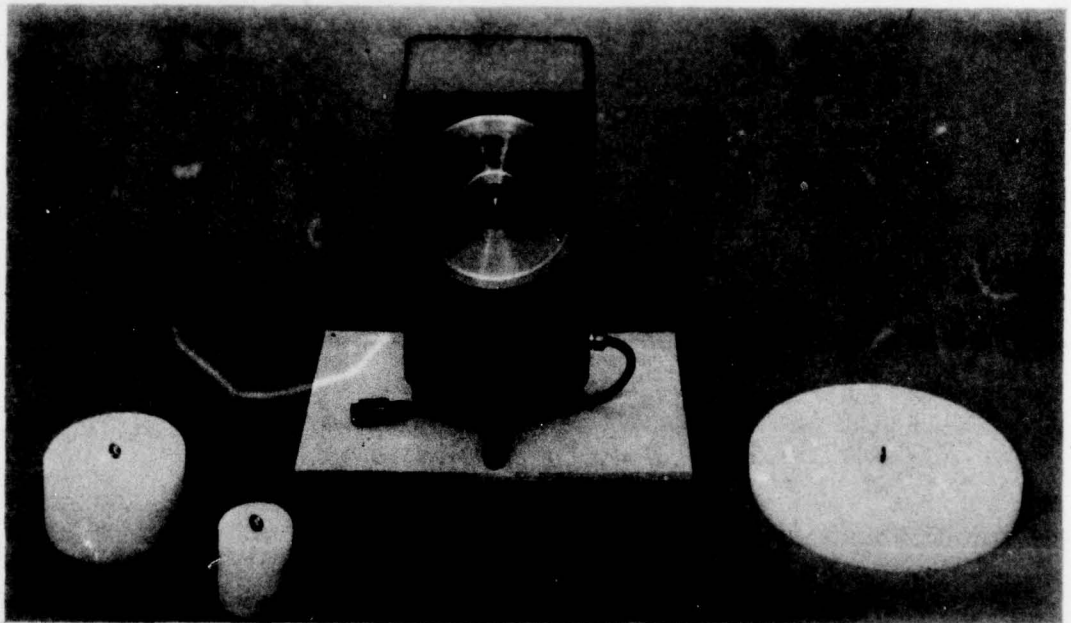


Figure 11. Universal Engineered Systems Model T-66
water-level sensor and floats

ENVIRONMENTAL DATA
ON
UPPER BLAKLEY ISLAND DISPOSAL AREA
MILITARY COORDINATES 610732
MOBILE ALABAMA
RECORD PERIOD: 9 JAN -15 JAN 1976

DATE	SAMPLE #	* WIND	* WIND	* SOLAR	* SOLAR	* WIND	* WIND	* SOIL	* SOIL	* AIR	* EVAP
TIME		* WIND	* WIND	* RAD	* RAD	* DIREC	* DIREC	* TEMPER	* TEMPER	* TEMPER	* RATION
HR MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	NO. 9	NO. 10	NO. 11	NO. 12
13	1	76									
10:15	0.00	4.12	2.43	7.76	11.55	157.00	179.50	17.90	12.80	16.20	27.13
10:30	0.51	5.18	3.92	6.55	0.00	135.50	183.50	17.90	12.80	16.30	27.13
10:45	0.00	5.28	4.06	5.11	0.00	151.00	202.00	17.90	12.90	16.40	27.13
11:00	0.00	5.30	3.69	26.35	0.00	142.00	186.50	17.90	13.00	16.20	27.20
11:15	0.00	5.16	4.07	13.74	0.00	146.00	179.00	17.90	13.00	16.80	27.20
11:30	0.00	5.09	4.24	48.20	0.00	136.50	170.50	17.90	13.10	16.80	27.13
11:45	0.00	4.70	4.58	12.52	0.00	153.00	192.00	17.90	13.20	16.60	27.05
12:00	0.00	4.99	3.91	6.06	0.00	145.50	180.00	17.90	13.20	17.10	27.20
12:15	0.00	4.46	2.37	8.58	0.00	168.00	191.50	17.90	13.30	16.40	27.20
12:30	0.00	4.47	2.47	7.05	0.00	142.00	181.50	17.90	13.40	16.90	27.13
12:45	0.00	5.05	3.51	6.10	0.00	143.50	183.00	17.90	13.40	16.70	27.20
13:00	0.25	5.20	4.01	0.00	0.00	152.50	107.50	17.90	13.50	16.70	27.28
13:15	1.27	3.97	2.02	5.47	0.00	153.50	204.00	17.90	13.60	16.40	27.28
13:30	0.00	4.30	2.57	3.58	0.00	159.50	188.00	17.90	13.60	16.80	27.28
13:45	0.25	4.78	3.43	7.17	0.00	147.00	204.50	17.90	13.70	16.90	27.20
14:00	0.00	4.45	3.11	5.00	0.00	138.50	182.50	17.90	13.70	16.80	27.28
14:15	0.00	3.20	1.65	2.66	0.00	126.50	185.00	17.90	13.80	16.50	27.20
14:30	0.00	3.10	1.50	0.00	0.00	144.00	182.00	17.90	13.80	16.20	27.28
14:45	0.00	2.33	0.33	0.00	0.00	118.50	165.50	17.90	13.80	16.20	27.28
15:00	0.00	2.80	0.84	0.00	0.00	133.00	168.00	17.90	13.90	15.90	27.28
15:15	0.00	2.76	0.08	0.00	0.00	123.00	164.50	17.90	13.90	15.80	27.28
15:30	0.00	2.38	0.23	0.00	0.00	138.00	162.50	17.90	13.90	15.30	27.28
15:45	0.00	2.18	0.10	0.00	0.00	138.50	175.00	17.90	14.00	15.80	27.28
16:00	0.00	1.59	0.00	0.00	0.00	112.50	163.00	17.90	14.00	15.50	27.28
16:15	0.00	1.59	0.00	0.00	0.00	97.00	143.50	17.90	14.00	15.00	27.28
16:30	0.00	2.14	0.14	0.00	0.00	112.00	149.00	17.90	14.00	14.30	27.28
16:45	0.00	2.12	0.14	0.00	0.00	111.00	148.50	17.90	14.00	13.70	27.28
17:00	0.00	2.95	2.48	0.00	0.00	124.50	113.50	17.90	14.00	13.20	27.28
17:15	0.00	1.48	0.00	0.00	0.00	95.00	142.00	17.90	13.90	13.00	27.28
17:30	0.00	1.84	0.00	0.00	0.00	89.50	142.50	17.90	13.90	13.20	27.28
17:45	0.00	1.73	0.00	0.00	0.00	100.00	134.00	17.90	13.90	13.00	27.28
18:00	0.00	1.93	0.00	0.00	0.00	90.00	138.00	17.90	13.90	13.00	27.28
18:15	0.00	1.48	0.00	0.00	0.00	121.00	166.50	17.90	13.90	13.40	27.28
18:30	0.00	1.96	0.36	0.00	0.00	183.00	245.50	17.90	13.90	17.20	27.28
18:45	0.00	3.07	1.47	0.00	0.00	101.50	154.50	17.90	13.90	14.00	27.28
19:00	0.00	2.26	0.46	0.00	0.00	190.00	236.50	17.90	13.90	17.20	27.28
19:15	0.00	2.72	1.24	0.00	0.00	129.00	143.00	17.90	13.80	13.60	27.28
19:30	0.00	2.57	0.64	0.00	0.00	190.00	207.50	17.90	13.80	17.00	27.28
19:45	0.00	4.09	2.92	0.00	0.00	198.50	223.50	17.90	13.80	17.80	27.28
20:00	0.00	4.69	3.17	0.00	0.00	227.00	247.50	17.90	13.80	18.00	27.28
20:15	0.00	4.78	3.46	0.00	0.00	187.50	239.50	17.90	13.80	17.90	27.20
20:30	0.00	4.71	4.04	0.00	0.00	233.50	270.00	17.90	13.80	18.20	27.28
20:45	0.00	5.03	4.11	0.00	0.00	185.50	243.50	17.90	13.90	18.00	27.28
21:00	0.00	5.00	3.94	0.00	0.00	196.00	224.50	17.90	13.90	17.70	27.28

Figure 12. Computer printout of environmental data on Upper Blakeley Island disposal area, Mobile, Alabama

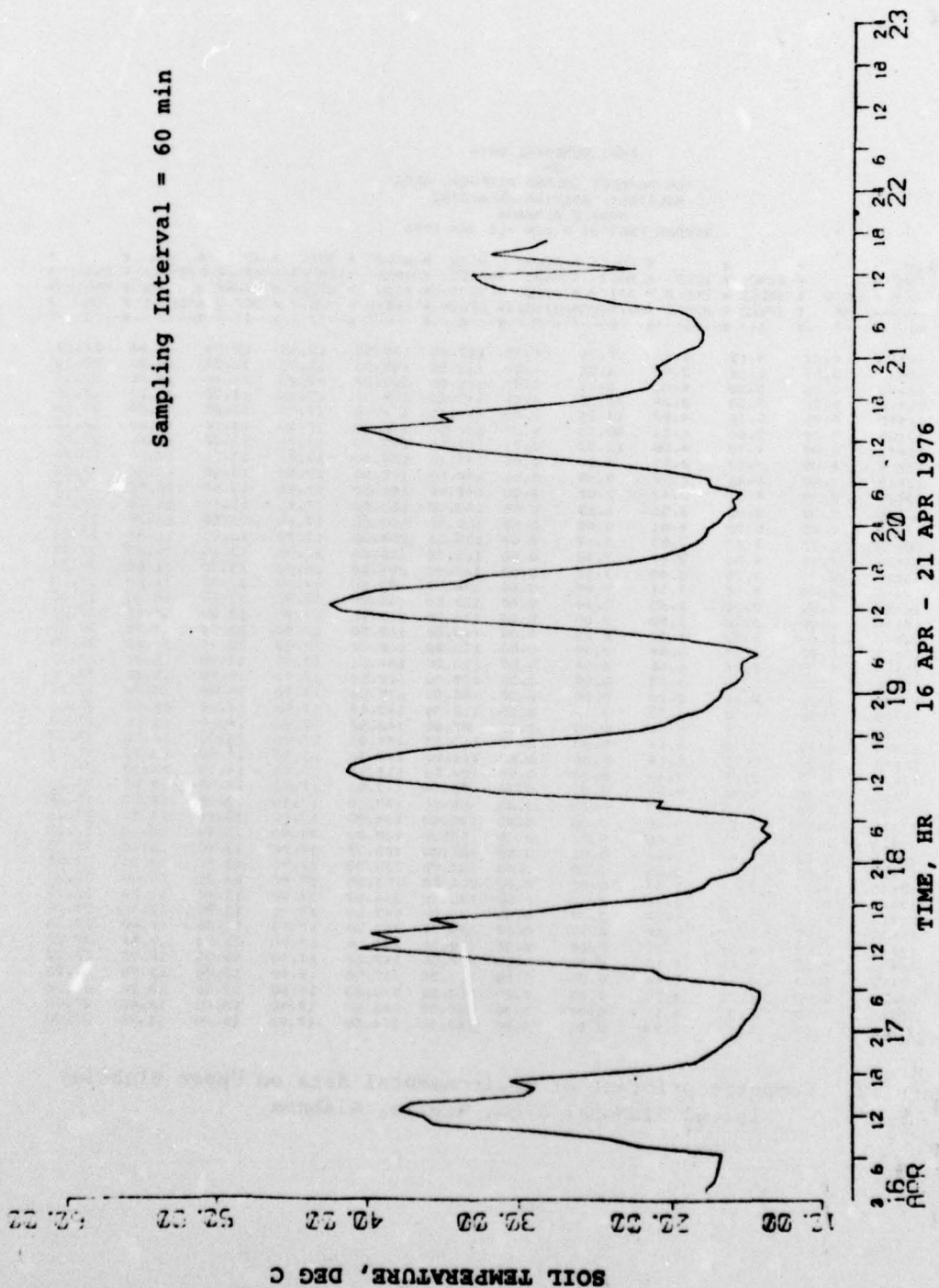
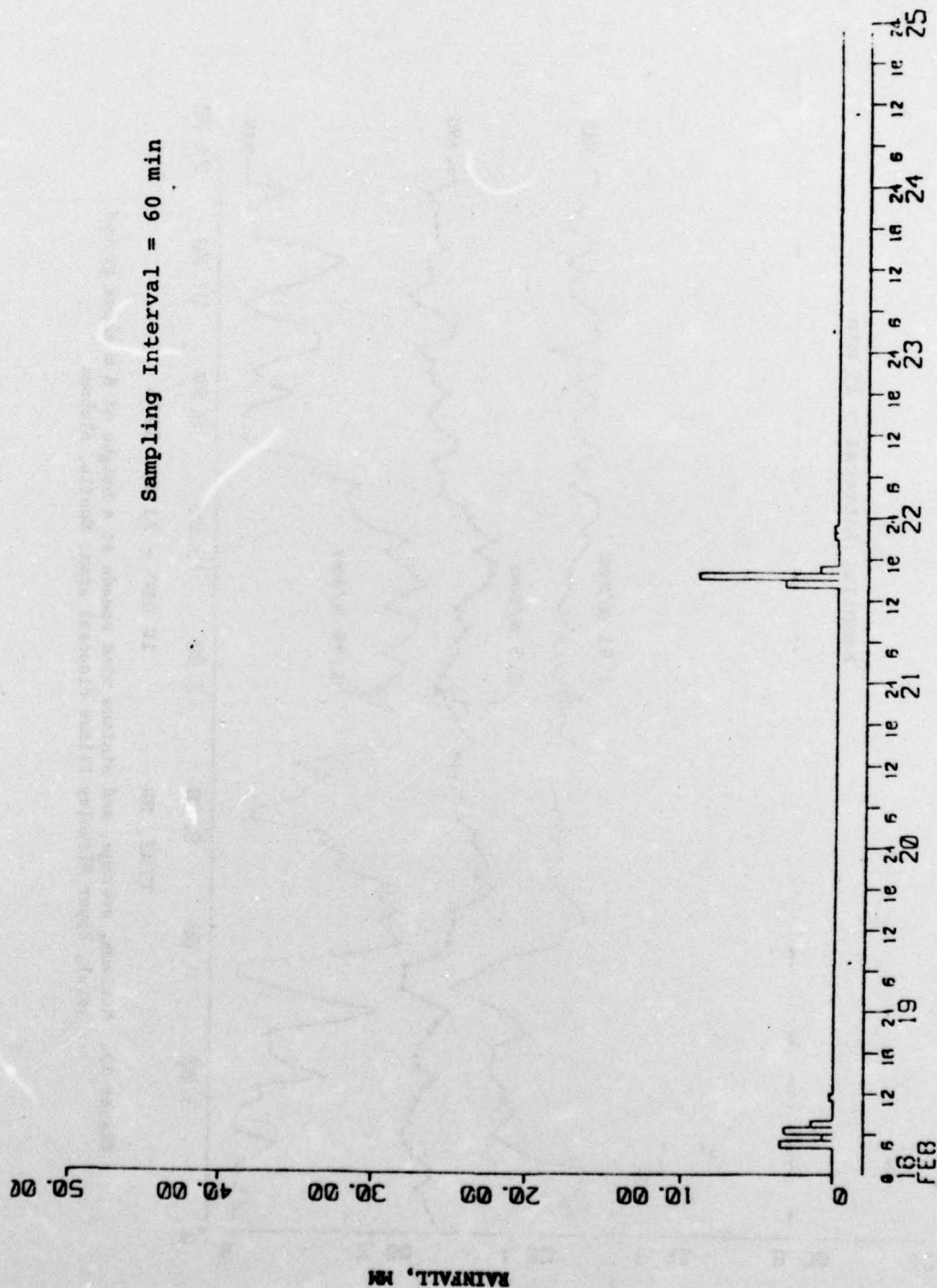


Figure 13. Soil temperature measurements at 0.15-m depth, Upper Blakeley Island disposal area, Mobile, Alabama



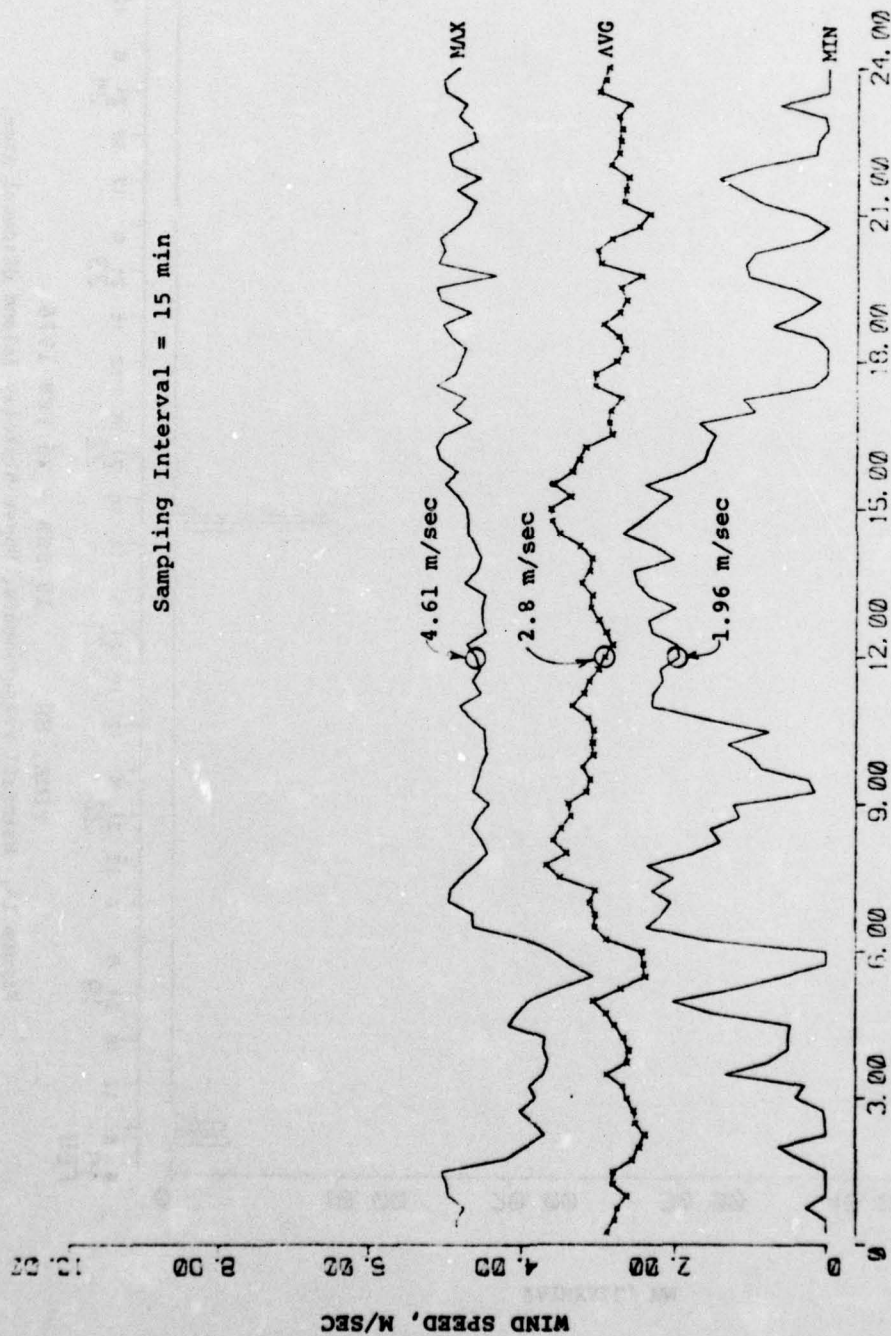
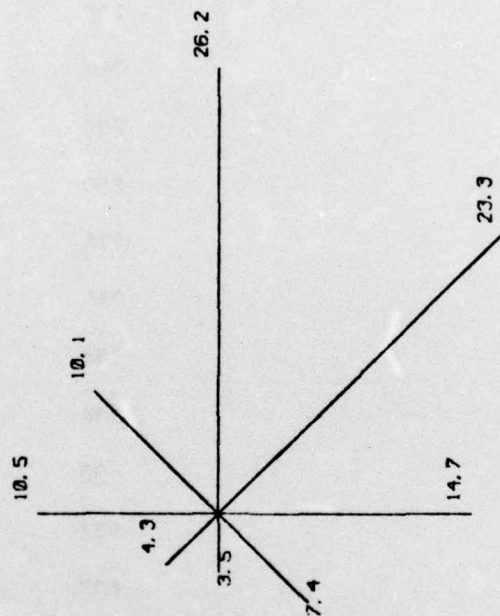


Figure 15. Maximum, average, and minimum wind speeds at a height of 8 m above ground level, Upper Blakeley Island disposal area, Mobile, Alabama

N

Sampling Interval = 60 min



NOTE: Numbers indicate the percentage frequency that the winds blow from each of the eight principal directions

PERCENTAGE FREQUENCY WIND DIRECTION AT 8 M, UPPER BLAKELEY ISLAND
DISPOSAL AREA, MOBILE, ALABAMA

9 APR - 21 APR 1976

Figure 16. Wind direction rose for position 8 m above ground level

<u>Number of Records</u>	<u>Number of Recorder Counts for 3-min Interval</u>
1	703
2	760
3	700
4	740
5	700
6	650
7	774
8	710
9	534
10	884
11	600
12	523
13	608
14	593
15	557
16	641
17	711
18	694
19	667
20	767
<hr/>	
Total	13,615

Figure 17. Raw wind-speed data taken from LEC recorder laboratory test tape

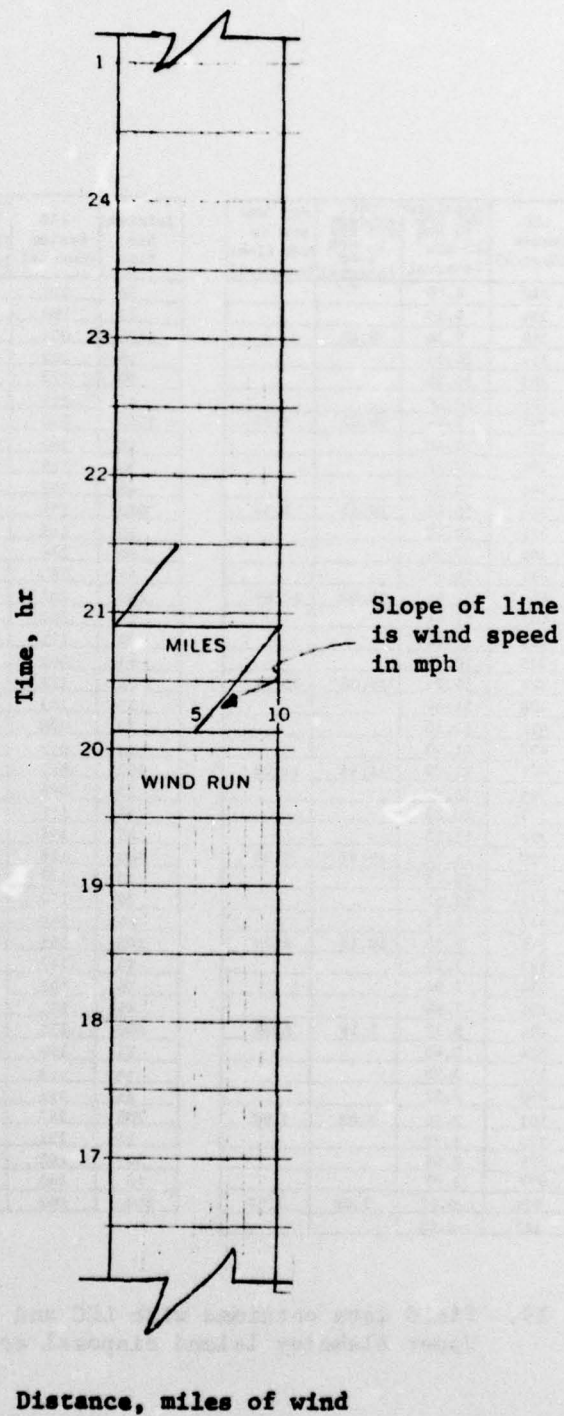


Figure 18. Wind-speed data taken in laboratory with MRI strip-chart recorder

Interval End Time	LEC System (Counts)	Calculated WND SPD in MPH (15-min Interval)	LEC Average WND SPD in MPH 1-hr Interval	MRI WND SPD in MPH (1-hr Interval)
1030	246	6.90		
45	303	8.55		
1100	348	9.76	8.40	
15	337	10.01		
30	363	10.18		
45	366	10.26		
1200	344	9.64	10.02	9.75
15	371	10.40		
30	361	10.12		
45	385	10.79		
1300	374	10.49	10.45	9.79
15	371	10.40		
30	384	10.76		
45	399	11.19		
1400	416	11.66	11.00	10.69
15	407	11.41		
30	389	10.90		
45	385	10.78		
1500	383	10.74	10.96	10.99
15	408	11.44		
30	412	11.55		
45	407	11.40		
1600	406	11.39	11.45	11.08
15	383	10.79		
30	363	10.23		
45	397	11.13		
1700	398	11.14	10.82	9.86
15	384	10.76		
30	377	10.57		
45	347	9.73		
1800	340	9.53	10.15	8.79
15	257	7.20		
30	284	7.96		
45	281	7.88		
1900	204	5.72	7.19	6.84
15	124	3.48		
30	117	3.28		
45	090	2.52		
2000	102	2.86	3.03	3.97
15	135	3.78		
30	096	2.69		
45	039	1.09		
2100	024	0.67	2.06	3.45
15	123	3.45		

Interval End Time	LEC System (Counts)	Calculated WND SPD in MPH (15-min Interval)	LEC Average WND SPD in MPH 1-hr Interval	MRI WND SPD in MPH (1-hr Interval)
30	119	3.34		
45	100	2.80		
2200	064	1.79	2.85	3.73
15	102	2.86		
30	173	4.85		
45	211	5.92		
2300	210	5.89	4.88	5.38
15	180	5.05		
30	163	4.63		
45	152	4.26		
000	155	4.35	4.57	5.13
15	145	4.07		
30	196	5.50		
45	183	5.13		
100	245	6.87	5.39	5.91
15	267	7.49		
30	131	3.67		
45	045	1.26		
200	118	3.30	3.93	4.85
15	143	4.01		
30	088	2.47		
45	012	0.34		
300	013	0.36	1.80	3.34
15	086	2.41		
30	111	3.11		
45	154	4.32		
400	128	3.59	3.36	4.40
15	128	3.59		
30	170	4.77		
45	151	4.23		
500	145	4.07	4.17	5.29
15	147	4.12		
30	102	2.86		
45	153	4.29		
600	155	4.35	3.91	4.69
15	194	5.44		
30	225	6.31		
45	221	6.20		
700	247	6.93	6.22	6.37
15	232	6.51		
30	262	7.35		
45	260	7.29		
800	200	6.51	6.69	6.65

Figure 19. Field data obtained with LEC and MRI recorders,
Upper Blakeley Island disposal area, Mobile, Alabama

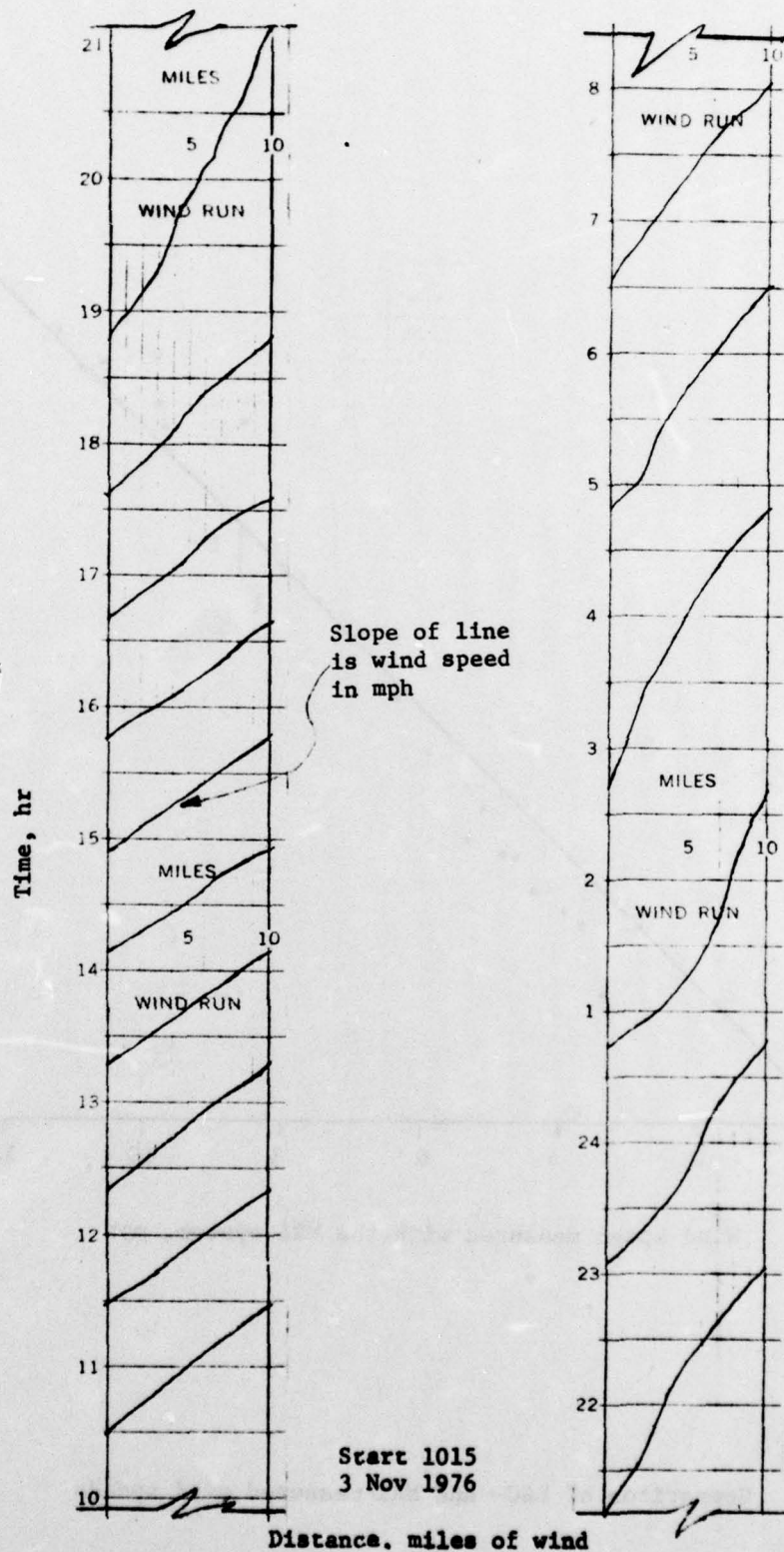


Figure 20. Wind-speed data from MRI strip-chart recorder taken at Upper Blakeley Island disposal area, Mobile, Alabama

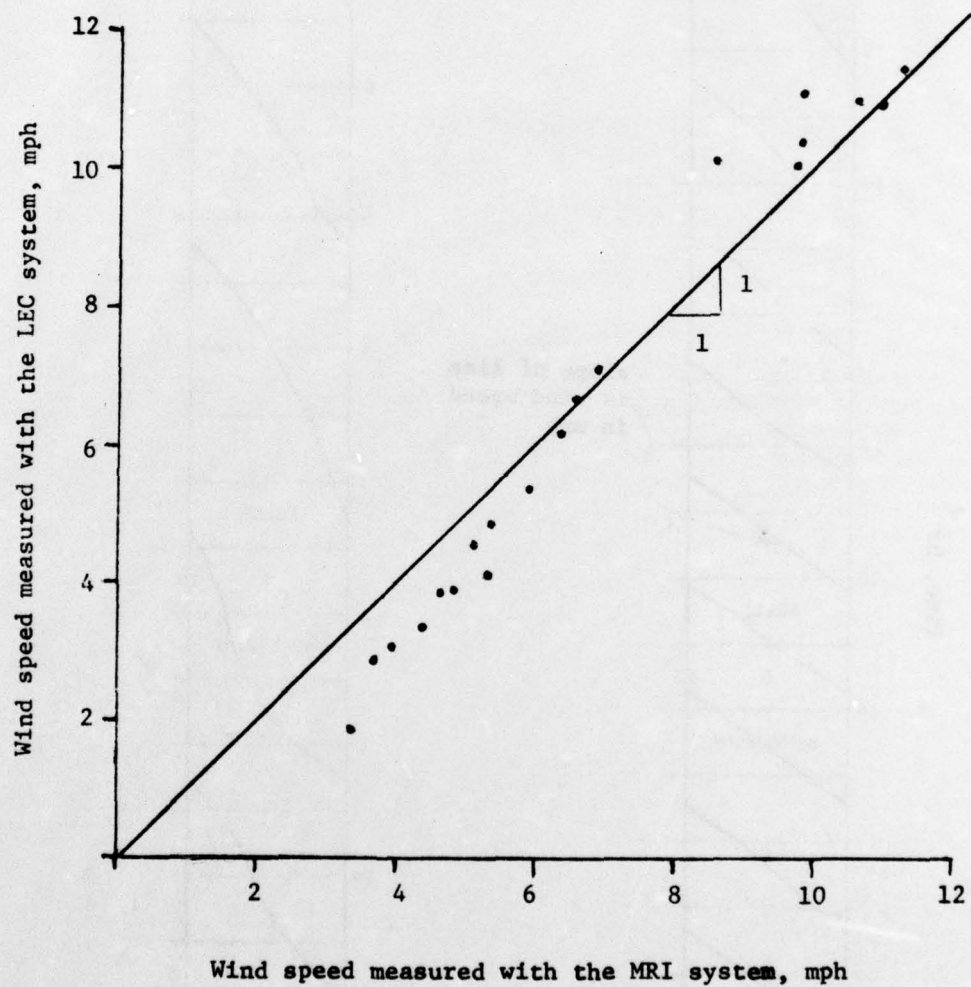


Figure 21. Comparison of LEC- and MRI-measured wind speeds

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Smith, Margaret H

Environmental data collected with automated field station at the Upper Blakeley Island disposal area, Mobile, Alabama, by Margaret H. Smith, Herman M. Floyd, and Harold W. West. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1977.

1 v. (various pagings) illus. 27 cm. (U. S. Waterways Experiment Station. Miscellaneous paper M-77-5)

Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C.

1. Data collection system. 2. Disposal areas. 3. Dredged material. 4. Environmental data. 5. Instrumentation. 6. Meteorological data. 7. Rain and rainfall. 8. Recording instruments. 9. Upper Blakeley Island. 10. Wind velocity. I. Floyd, Herman M., joint author. II. West, Harold W., joint author. III. U. S. Army. Corps of Engineers. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Miscellaneous paper M-77-5)
TA7.W34m no.M-77-5